MECHANICAL ENGINEERING

Paper : I

Grade : V(A) Degree

Full Marks – 200

Time – Three hours

The figures in the margin indicate full marks for the questions.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A 15×6=90

Answer *all* questions.

Each question carries six marks.

1. Explain thermal stress and strain. 6

2. Define shear force and bending moment. What is the relation among bending moment, shear force and rate of loading ? 2+2+2=6

3. What are the advantages of welded joints over rivetted joints ? 6

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4. What is a kinematic chain ? What is the condition for a chain to be locked ? 2+4=6

5. Define the following terms in case of a governor : 2+2+2=6

   (i) Sensitiveness

   (ii) Isochronism

   (iii) Hunting.

6. Explain forced vibration with damping. What is critical speed of shaft ? 4+2=6

7. What are the advantages of V-belts over flat belts ? 6

8. What are the desirable properties of a good bearing material ? 6

9. What are the causes of gear tooth failure. 6

10. Define stream lines, path lines and streak lines. 2+2+2=6

11. Write Bernoulli's equation. What are the assumptions involved in the bernoulli's equation ? 2+4=6

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12. What is hydrodynamic boundary layer ? Write the significance of Reynold's number. 3+3=6

13. Compare between Water tube and Fire tube Boilers. 6

14. What are the various boiler mountings and their functions ? 6

15. What are the sources of heat losses in a boiler ? Define 'Equivalent Evaporation'. 3+3=6

GROUP – B 40×2=80

Answer *all* questions.

Each question carries *two* marks.

Choose the correct answer from the alternatives.

1. The extension of a uniforming tapering bar from dia D_2 at top to dia D_1 at bottom and having length l, under an axial load p is given by

(a) $\frac{4\pi pl}{ED_1D_2}$ (b) $\frac{4E\pi pl}{D_1D_2}$

(c) $\frac{4\pi D_1D_2}{Epl}$ (d) $\frac{4pl}{\pi ED_1D_2}$

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2. The shape of bending moment diagram for a simply supported beam carrying a number of concentrated loads is

(a) series straight lines

(b) a straight line

(c) a parabola

(d) None of the above.

3. The modulus of elasticity E, shear modulus N and Poisson's ratio $\frac{1}{m}$ are related through

(a) $N = 2E\left(1+\frac{1}{m}\right)$

(b) $E = 2N\left(\frac{1}{m}-1\right)$

(c) $E = 2N\left(1-\frac{1}{m}\right)$

(d) $E = 2N\left(1+\frac{1}{m}\right)$

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4. The major principal stress developod in a circular shaft under combined action of bending moment M and torsion T is given by

(a) $\frac{16d^3}{\pi}\left[M+\sqrt{M^2+T^2}\right]$

(b) $\frac{16}{\pi d^3}\left[M+\sqrt{M^2+T^2}\right]$

(c) $\frac{16}{\pi d^3}\left[M-\sqrt{M^2+T^2}\right]$

(d) None of the above.

5. The ratio of circumferential to longitudinal stress developed in a thin shell under internal pressure 'p' is

(a) 1 (b) 3

(c) 2 (d) 4

6. Effective length of a column of length 'L' fixed at one end and hinged at the other end is

(a) L (b) 2L

(c) $\sqrt{2}\,L$ (d) $\frac{L}{\sqrt{2}}$

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7. In a block subjected to normal stresses σ_x and σ_y and shear stress Ψ along two mutually perpendicular planes, the position of principal planes is given by

(a) $\sin 2\theta = \dfrac{2\psi}{\sigma_x - \sigma_y}$

(b) $\tan 2\theta = \dfrac{2\psi}{\sigma_x - \sigma_y}$

(c) $\tan 2\theta = \dfrac{2\psi}{\sigma_y - \sigma_x}$

(d) $\tan \theta = \dfrac{2\psi}{\sigma_x - \sigma_y}$

8. Newton's law of viscosity relates

(a) Shear stress and rate of angular deformation in a fluid

(b) Yield shear stress, rate of angular deformation and viscosity

(c) Pressure, viscosity and rate of angular deformation

(d) Shear stress, temperature, viscosity and velocity.

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9. For an irrotational flow the equation

$$\frac{\partial^2\phi}{\partial x^2}+\frac{\partial^2\phi}{\partial y^2}=0$$ is known as

(a) Bernoulli's equation

(b) Reynold's equation

(c) Euler's equation

(d) Laplace equation.

10. If the particle of a fluid attains such velocities that vary from point to point in magnitude and direction as well as from instant to instant, the flow is said to be

(a) Uniform flow

(b) Steady flow

(c) Turbulent flow

(d) Laminar flow.

11. The head loss due to sudden enlargement in a pipe is

(a) $\frac{v_1^2-v_2^2}{2g}$ (b) $\frac{(v_1-v_2)^2}{2g}$

(c) $\frac{(v_1-v_2)^2}{g}$ (d) $\frac{v_1^2-v_2^2}{g}$

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12. A fluid having mass ρL^2, area L^2, length L and velocity L/T has a force acting on it and expressed by $\rho L^3 g$. Identify the force

(a) Inertia force

(b) Viscous force

(c) Pressure force

(d) Gravity force.

13. The horizontal component of force on a curved surface is equal to

(a) Weight of the liquid vertically above the curved surface

(b) Weight of the liquid retained by the curved surface

(c) Pressure at centroid X area

(d) Force on the vertical projection of the curved surface.

14. Dimension of viscosity is

(a) FLT^2 (b) FL^2T

(c) $FL^{-1}T^{-1}$ (d) $FL^{-2}T$

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15. The total number of instantaneous centres for a mechanism of n links in

(a) n

(b) $(n-1)$

(c) $n(n-1)$

(d) $\frac{n(n-1)}{2}$

16. For T as the belt tension when w is the weight per unit length of belt, the maximum permissible velocity of the belt is given by

(a) $v = \sqrt{\frac{Tg}{3w}}$

(b) $v = \sqrt{\frac{3Tg}{w}}$

(c) $v = \sqrt{\frac{3wg}{T}}$

(d) $v = \sqrt{\frac{3Tw}{g}}$

17. In case of gears, higher pressure angle results in

(a) Wider base and stronger teeth

(b) Narrow base and weaker teeth

(c) Wider base and weaker teeth

(d) Narrow base and stronger teeth.

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18. The locus of a point on the circumference of a circle which rolls without slipping on a fixed straight line, is known as

(a) Involute

(b) Epicycloid

(c) Cycloid

(d) Hypo cycloid.

19. At critical speed

(a) The shaft runs smoothly

(b) The shaft runs with noise due to vibrations

(c) The shaft becomes dynamically unstable with negligible lateral amplitudes

(d) The shaft becomes dynamically unstable with large lateral amplitudes.

20. The equation $m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = F \sin wt$ represents

(a) Free vibrations

(b) Forced vibrations

(c) Free vibrations with viscous damping

(d) Resonant vibrations.

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21. In automobiles, Hooke's joint is used between

(a) Flywheel and clutch

(b) Clutch and gear box

(c) Gear box and differential

(d) Differential and wheels.

22. The life of ball bearings as listed in cataloguee represents

(a) 90% survival rate

(b) 75% survival rate

(c) 50% survival rate

(d) 25% survival rate.

23. Gas lubricated bearings are used for

(a) Very low r.p.m and high load applications

(b) Very low r.p.m and low load applications

(c) Very high r.p.m and low load applications.

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24. In journal bearing $\frac{L}{D}$ ratio seldom exceeds 2 due to

(a) economic considerations

(b) risk of metal to metal contact

(c) heat dissipation problems

(d) need of higher lubricating oil pressures.

25. In case of gears, Addendum is

(a) The depth of a gear tooth

(b) Half the depth of a gear tooth

(c) Depth of tooth space below the pitch circle

(d) Height by which tooth projects beyond the pitch circle.

26. The deflection of a helical spring is

(a) Directly proportional to d^2

(b) Directly proportional to d^3

(c) Directly proportional to d

(d) Directly proportional to d^4

(d is the diameter of wire)

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27. For a square threaded screw (angle of friction ϕ), the maximum efficiency of the screw jack will be

(a) $\frac{1+\tan\phi}{1-\tan\phi}$ (b) $\frac{1-\tan\phi}{1+\tan\phi}$

(c) $\frac{1-\sin\phi}{1+\sin\phi}$ (d) $\frac{1+\sin\phi}{1-\sin\phi}$

28. The thickness of a gear tooth is measured

(a) along the pitch circle

(b) along the root circle

(c) along the outer circle

(d) average of the profile.

29. If a centrifugal pump takes too much power, the cause may be

(a) low speed

(b) air in water

(c) air leakage

(d) heavy liquid.

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30. Air vessels in a reciprocating pump are fitted to

(a) reduce the acceleration head

(b) reduce suction head

(c) increase delivery head

(d) increase the opening speed of pump.

31. A Francis turbine is

(a) inward flow reaction turbine

(b) inward flow impulse turbine

(c) outward flow reaction turbine

(d) outward flow impulse turbine.

32. If the specific speed of a turbine is 800, the turbine should be

(a) Francis

(b) Kaplan

(c) Pelton wheel

(d) None of the above.

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33. A hydro electric plant is usually termed as high head plant when the head is

(a) More than 15m

(b) More than 25m

(c) More than 35m

(d) More than 45m.

34. The falling drops of rain acquire spherical shape on account of

(a) Vapour pressure

(b) Surface tension

(c) Compressibility

(d) Buoyancy.

35. The basic purpose of drum in boiler is to

(a) serve as storage of steam

(b) serve as storage of feed water for water wall

(c) remove salts from water

(d) separate steam from water.

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36. The diameter of tubes for natural circulation boiler as compared to controlled circulation boilers is

(a) more (b) less

(c) same (d) None of the the above.

37. The economiser is used in boilers to

(a) increase thermal efficiency of boiler

(b) extract heat from the exhaust flue gases

(c) increase flue gas temperature

(d) to heat feed water by bled steam.

38. Power point of fuel in the

(a) storage temperature

(b) lowest temperature at which oil will flow under set condition

(c) temperature at which fuel is pumped through burners

(d) temperature at which oil is transported.

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39. Incomplete combustion can be best judged by

(a) smoky chimney exit

(b) excess air in flue gases

(c) measuring carbon mono-oxide in flue gases

(d) measuring temperature of flue gases at exit of furnace.

40. Evaporative capacity of boiler is expressed as

(a) kg of steam produced

(b) steam pressure produced

(c) kg of fuel fired

(d) kg of steam produced per kg of fuel fired.

GROUP – C

5×6=30

Answer *all* the questions.

Each question carries six marks.

1. A point in a strained material is subjected to a tensile stress of 130 N/mm² in x-direction and a compressive stress of 90 N/mm² in y-direction. The stresses are also accompanied by a shear stress of 40 N/mm². Draw Mohr's circle and find the principal stresses and maximum shear.

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2. In a plate clutch, the axial force is 4500 N. The inner radius of contact is 500 mm and the outside radius is 100 mm. Assuming uniform wear, determine

   (a) maximum pressure

   (b) minimum pressure

   (c) average pressure.

3. A single-row deep groove ball bearing has a dynamic load capacity of 40500 N and operates on the following work cycle

   (i) radial load of 5000 N at 500 r.p.m for 25% of the time

   (ii) radial load of 10000 N at 700 r.p.m for 50% of the time, and

   (iii) radial load of 7000 N at 400 r.p.m for the remaining 25% of time.

   Calculate the life of the bearing in hours.

4. A triangular plate of base width 1.5m and height 2m lies immersed in water with the apex downwards. The base is 1m below and parallel to the free water surface. Calculate the total pressure on the plate and the depth of centre of pressure.

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5. A horizontal water pipe of dia 15 cm converges to dia 7.5 cm. If the pressures at the two sections are 4 kgf/cm^2 and 1.5 kgf/cm^2 repectively, calculate the flow rate of water.

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